sur une période d'un an. Grâce à l'observation et à une série d'entrevues, les enseignants sont également amenés à réfléchir sur l'efficacité des techniques choisies, les sources qui soutiennent leur démarche, les dilemmes auxquels ils sont confrontés, leurs façons de faire face à ces dilemmes et enfin les aspects qui nécessitent un travail supplémentaire. Parmi les techniques d'évaluation authentique utilisées, mentionnons le journal de bord, l'évaluation de la performance, les rubriques, les listes de contrôle, l'évaluation par les pairs et l'autoévaluation.

Plusieurs aspects se sont avérés communs aux cinq participants. Les enseignants étaient tous fermement convaincus de l'importance de l'évaluation authentique. Parmi les raisons invoquées, citons la volonté d'insérer les mathématiques dans un contexte réaliste, l'importance de développer des compétences pour ce qui est des modes de pensée et de la résolution de problèmes, la nécessité pour les étudiants de comprendre les concepts mathématiques plutôt que d'imiter les processus algorithmiques, et enfin le fait que l'acquisition de connaissances métacognitives favorise l'apprentissage. Parmi les dilemmes les plus importants aux yeux des participants, mentionnons le difficile équilibre entre les attentes traditionnelles liées au curriculum et les activités d'évaluation authentiques, l'absence de critères de correspondance entre les nouvelles techniques d'évaluation et les méthodes traditionnelles, le sentiment d'isolement ou d'aliénation par rapport aux collègues, et le manque de temps pour explorer ou mettre au point de nouvelles ressources à intégrer dans les curriculums.

En résumé, les aspects clés qui préoccupent principalement les participants sont l'importance de lier entre eux le curriculum, l'enseignement et l'évaluation ; le rôle actif que jouent les administrateurs lorsqu'il s'agit de favoriser une réforme des pratiques dans le domaine de l'évaluation ; et enfin l'importance du soutien que pourrait fournir une certaine culture de collaboration chez les enseignants. En conséquence, cette étude a des implications significatives pour les enseignants et pour tous ceux qui ont à cœur la croissance professionnelle et le perfectionnement pédagogique des enseignants dans le domaine de l'évaluation.

Reform in mathematics education

In order to examine new techniques in mathematics assessment, it is first necessary to review the trends in mathematics education reform over the past decade and more. Mathematics education reform grew out of a perception that students were ill prepared mathematically to face the twenty-first century. *A Nation at Risk* (National Commission on Excellence in Education [NCEE], 1983) brought forward concerns about students' mathematical competence. In response to *A Nation at Risk*, two schools of thought emerged. One school urged a traditional approach that suggested a focus on the acquisition of mathematics 'skills' through rote memorization of algorithms that quickly brought students to an answer. The other school of thought encouraged understanding of mathematics through a constructivist approach with a focus on problem solving. *Curriculum and Evaluation Standards for School Mathematics* (National Council of Teachers of Mathematics [NCTM], 1989) was a seminal work that set guidelines for this problem-solving approach to mathematics. The new goals of mathematics education suggested

> that students should be exposed to numerous and varied interrelated experiences that encourage them to value the mathematical enterprise, to develop mathematical habits of mind, and to understand and appreciate the role of mathematics in human affairs; that they should be encouraged to explore, to guess, and even to make and correct errors so that they gain confidence in their ability to solve complex problems; that they should read, write, and discuss mathematics; and that they should conjecture, test, and build arguments about a conjecture's validity. (NCTM, 1989, p. 5)

This document and its more recent version, *Principles and Standards for School Mathematics* (NCTM, 2000), suggest that students should be able to build new mathematical knowledge through solving problems that arise in mathematics and other contexts. Thus, instructional and assessment tasks should emphasize connections within mathematics by embedding mathematics in relevant extended contexts that encourage students to explore and communicate mathematically (Mathematical Sciences Education Board and National Research Council [MSEB & NRC], 1993). Many

have argued that students learn mathematics as they construct meanings for themselves through mathematical activity (Davis, Maher, & Noddings, 1990; Even & Tirosh, 2002).

The reform in mathematics education rests on the belief that understanding mathematics is more valuable than memorizing algorithms, and the use of problem solving puts the emphasis on students' 'understanding mathematics.' Studies support the claim that solving open-ended problems increases understanding and makes use of higher-order thinking skills (Romberg, Zarinnia, & Collis, 1990). Wood and Sellers (1997) indicate that students from problem-centred mathematics classrooms have a better understanding of mathematics and hold different beliefs about mathematics than students from other classrooms. Furthermore, metacognitive skills are both called upon and developed as students engage in mathematics problem solving (Brown & Baird, 1993; Schoenfeld, 1992).

A classroom environment where exploration is encouraged and perseverance is rewarded is likely to help students become good problem solvers. With encouragement and specific feedback from teachers, students develop an awareness of their own strategies and specific needs as they struggle with complex problems. The teacher can probe student thinking and encourage student suggestions while making it clear that solutions must ultimately meet certain mathematical standards (NCTM, 2000).

What is authentic assessment?

In a problem-centred curriculum, new assessment techniques that align with classroom activities and seek to assess students' understanding of mathematics concepts are required. Since traditional tests often focus only on the answer or the use of a suitable algorithm to reach the answer, authentic assessment techniques need to be employed to provide a broader range of measures. In this article, the term *authentic assessment* is used to describe assessment of this type: assessment that involves students in tasks that are worthwhile, significant, and meaningful and that resemble learning activities. Such assessment activities also encourage risk taking, allow for mathematical communication, and provide the opportunity to demonstrate the application of knowledge in unfamiliar settings. Other terms that are often used for authentic assessment include alternative, performance-based, or outcome-based assessment (Hart, 1994).

To capture the multi-faceted aspects of the problem-solving approach, a broad range of assessment techniques needs to be employed, such as structured interviews, concrete models, group problem solving, creative projects, and portfolio evaluations, as well as paper-and-pencil tests (Clarke, 1992; Goldin, 1992; Lampert, 2001). Authentic assessment includes the use of open-ended problems, scoring rubrics, student self-assessment, mathematics portfolios, and student journals. When a wide variety of these assessment techniques is used, teachers gain insight into the student's thinking and understanding of mathematics and students learn to describe their own problem-solving strategies (Maher, Davis, & Alston, 1992; Schoen, Cebulla, Finn, & Fi, 2003).

Design of the inquiry

The case studies reported in this article examine the beliefs, practices, and concerns of five teachers over a 1-year period and consider the support they require. In order to unearth their thoughts and experiences, multiple methods of data collection were used. A preliminary interview was held with each participant. Its purpose was to present the project and answer prospective participants' questions. These preliminary interviews were followed by four sets of individual interviews, one at the beginning of the project, two in the middle (following each of the observations), and one at the end. In most cases, the first interview elicited the extent to which authentic assessment was used in that teacher's classroom, the teacher's views on mathematics education, resources that aided the teacher with authentic assessment, and areas that created stumbling blocks

to implementation. Two focus-group meetings were also held. Here teachers were able to discuss their assessment practices with one another. Furthermore, these served as support and facilitated an exchange of ideas. Each teacher's classroom was observed on two occasions when she or he was using authentic assessment to note how assessment practices played out. This provided a context through which to identify the practices that the teachers spoke of in their interviews. Each observation was followed by an interview, sometimes in person, sometimes by telephone due to hectic schedules, to obtain the teacher's perceptions of and response to the assessment activities. Throughout the study, samples of authentic assessment instruments that the teachers used, as well as school or department evaluation policies that would affect assessment practices, were collected. Each teacher maintained an assessment logbook, to supplement the interview and observation data, in which s/he frequently recorded the nature of their use of authentic assessment, including comments or reflections on the implementation of the particular assessment strategy. In most cases, the teachers included samples of the activity, samples of the assessment for that activity, and actual student responses, in order to fully 'round out' their brief description.

The participants

The five teachers selected for the study had already been incorporating some authentic assessment techniques into their secondary school mathematics classrooms. The teachers, all in the same school board, had been identified by the board mathematics coordinator as teachers who were attempting to use new assessment methods and they all agreed to be part of the study. The teachers came from four different schools, with two of the teachers at the same school. The teachers themselves were at very different stages in their careers and, consequently, issues of experience could emerge. As well, they varied in their expertise with authentic assessment, again allowing for differences to surface. An introduction to the participants and settings, identified by pseudonyms, follows.

Two of the participants, Gwen and Julia, taught at the same school. Gwen was completing her sixth year of teaching when the study began. Her teaching experience included a first year of teaching in an elementary school, followed by 5 years of teaching secondary school mathematics and computer science. She had an undergraduate degree in physical education and, at the time of the study, was taking courses towards a Master of Education degree. She had obtained her teaching qualifications in mathematics through additional qualification courses, following her first year of teaching. Julia was completing her fourth year of teaching at the start of the study and all of her teaching experience had been at the one school. Julia had wanted to be a mathematics teacher since she was in high school, where she participated in mathematics contests and volunteered as a peer tutor in mathematics classes. She then obtained her undergraduate degree in mathematics.

Dave was an experienced teacher who was in his first year as head of the mathematics department at his school. He was very involved in a local chapter of the provincial mathematics educators association. He frequently presented at conferences, both within the school board and at the provincial level. Dave had been teaching for 20 years, with a 5-year break in the middle of his teaching career when he was a financial planner. He has also had some experience teaching at the college level.

Miriam was an experienced teacher, who had taught for over 20 years and was the department head of mathematics at a large suburban high school. Miriam served on various committees in the school board that dealt with assessment and specifically with developing assessment scales for numeracy skills. She also taught a summer institute course to teachers within the board on using numeracy assessment scales.

Luke had been teaching for 11 years at both elementary and secondary levels. Luke had started his career teaching mathematics and working with students with specific learning needs in an elementary school for 2 years. He then moved into secondary school mathematics teaching and, at the

beginning of the study, he was teaching mathematics at a large secondary school and was the assistant department head of mathematics. He had been at the school for about 6 years and, at the time, was teaching Grade 9, Grade 12, and calculus. In the middle of the study, after teaching secondary school mathematics for 8 years, Luke decided to make another change and moved from the secondary school to a senior elementary school to teach Grade 8 mathematics. Thus, during the second half of this study, Luke was teaching Grade 8 mathematics.

In summary, involved in the study there were two very experienced teachers who were also department heads, two teachers who were fairly new to the profession, and one teacher in the middle of his career. Two of the participants were male and three were female. They also had a variety of backgrounds and experiences, some with degrees in mathematics and others with degrees in other disciplines but with the required training to become mathematics teachers. Most of them were teaching at the secondary school level, with Luke moving to the Grade 8 level mid-way through the study. The common element was their choosing to include authentic assessment methods in their practice.

Findings

What the teachers were doing

Several areas were common to all five of the participants. The teachers had firm beliefs as to why it was important to use authentic assessment, including the beliefs that mathematics should be set in a realistic context; that developing thinking and problem-solving skills is critical; that understanding mathematics concepts rather than imitating algorithmic processes is essential; and that the development of metacognitive skills enhances students' learning.

All five participants had decided to include authentic assessment activities while working in a fairly traditional mathematics curriculum setting. Their teaching style, therefore, was dichotomous. At times, they used a traditional approach of giving examples at the chalkboard, after which students practised the skill. Other times, they engaged students in active problem solving that focused on developing mathematical understanding, presenting mathematics in context, and encouraging communication about mathematics. The goal, in the second instance, was for students to increase their understanding and to make connections among mathematics, other disciplines, and their world.

Each participant included group problem-solving activities as part of the classroom routine. Students were often presented with an open-ended problem, given in a realistic context. Students were encouraged to investigate the problem and to determine and present a solution. Problems often incorporated recently acquired skills or were an introduction to a new set of skills to be learned in a necessary circumstance. Such experiences agree with the definition of problem solving offered by Ginsberg et al. (1992) as being active, conjecturing, modelling, and applying skills. Frequently, students were given tools to help them solve the problem, such as manipulatives, chart or graph paper, graphing calculators, and/or computers. As Franke and Carey (1997) suggest, these concrete materials help bridge the gap between formal and informal thinking for students. Student solutions to the problems posed by their teachers were presented in a variety of ways, including written submissions with full justification for their answers and presentations of the solutions to the class, often using visuals or demonstrations. The teachers assessed these problem-solving situations through observation checklists while students worked, rubrics to determine levels of performance of a written submission, and teacher or peer assessment of classroom presentations.

All teachers demonstrated an intrinsic link between the types of activities they were doing and the assessment strategies they were using. As part of developing these classroom activities, the teachers also developed methods of assessing the activities, most of which could be called authen-

tic assessment. Thus, another commonality was that all of the participants were striving to link their new instructional practices with new assessment practices. Similar results have been reported in several studies (Kulm, 1994; Lehman, 1995). New instructional practices necessitated new assessment practices. Teachers were choosing classroom activities to enhance the student's learning and the assessment grew out of the nature of the tasks that they were asking students to perform. 'You plan an activity and then you decide how it would be best to assess it' (Julia, informal discussion). The development of reflection and self-assessment in their students was also important to the participants. Assessment methods that were developed, therefore, encouraged the growth of metacognitive skills, such as self-reflection, responsibility for one's own learning, and self-confidence. This was exemplified by the use of portfolios by Gwen, strategic planning by Luke, learning logs by Miriam, and journals and questioning by Dave and Julia.

Why the teachers were using authentic assessment

None of the participants had been mandated to use authentic assessment in their classrooms. Rather, the choice to use authentic assessment activities was made by each individual teacher and came as a result of trying to link her/his assessment strategies to instructional practice. All of the teachers in the study had been introduced to new assessment strategies and problem-solving activities through their own professional development, reading, and voluntary attendance at workshops and conferences.

The reasons for using authentic assessment were interwoven through all of the interviews and focus-group meetings and a variety of reasons emerged. Ultimately, their choosing to use authentic assessment was a result of their choices of instructional activities. They chose such activities because they recognized the importance of applying mathematics in real contexts, creating connections between mathematics and the student's world, developing problem-solving skills, creating a deeper understanding of mathematics, developing metacognitive skills, and encouraging students' responsibility for their own learning. While these intentions may appear as separate ideas, they are firmly woven together. For instance, a teacher provides students with a problem-solving application of mathematics in a real context with several purposes in mind: to deepen a student's understanding of mathematics, to help the student make connections, and to help the student build confidence in himself or herself as a problem solver.

One reason for using authentic assessment activities cited by several participants was the belief that mathematics should be applied in realistic contexts to deepen students' understanding of mathematics and so that students recognize the value of mathematics. Students need to see the applications of mathematics within the classroom to be better prepared for applying mathematics outside of the classroom. Miriam suggested, 'It is the math that people are going to use in their lives' (focus-group interview). Luke insisted that you could not have authentic assessment unless you have authentic mathematics. He described his impression of authentic mathematics:

> For me, the notion of authenticity is 'Is the mathematics you're doing actually authentic mathematics?' Or is it just an isolated topic. And is the teacher as leader telling kids what to do? Or is it a chance to explore? Are they behaving like true problem solvers? Is the stuff that we are assessing even authentic, never mind the techniques that we are using? So can you have authentic assessment with a traditional type of curriculum? (Luke, focus-group interview)

Developing problem-solving expertise was also seen as an important reason for choosing authentic assessment activities. Problem solving often grew naturally out of the mathematics in context, an application of mathematics, or a mathematical dilemma or conjecture. For these teachers, it was not only important that students be able to perform mathematical algorithms such as solving quadratic equations or using matrices to solve linear systems. It was equally important that they be able to take a realistic problem and interpret it in such a way that they could build a mathe-

matical model to solve the problem. This model could be algebraic, graphical, or geometric in nature. The leap between a problem in context and a mathematical model of the problem was often the most difficult one for students to make, especially if they were accustomed to mathematics in isolation. Yet, it is a significant one if they are going to be able to use mathematics outside of the classroom and see its relevance. This leap was also the crux of what these teachers called problem solving.

The teachers also believed that students reinforce their understanding of concepts through verbalization of those concepts. Gwen and Julia often used *think–pair–share* as a method of review. As students communicate with one another, the teacher circulates around the room and prompts where necessary. Gwen and Miriam discussed the benefits of students' working together and conferring about mathematics.

> **Gwen:** We really need to give them the opportunity to present things orally. Which they don't [normally do]. And they also need to write. I have kids do a lot of pair work where they have to explain to each other. 'Explain to your partner how to do this question.' If they [students] verbalize it, they understand it better.

> **Miriam:** Well, all kinds of research shows that if you tell someone else how to do it then you learn it better. (focus-group interview)

Developing students' confidence in doing mathematics was also important. Students require confidence to take necessary risks in problem solving, such as trying a different approach, brainstorming, or using trial and error. However, teachers also see that by engaging students in open-ended problem solving, where there is not necessarily only one correct answer and the teacher is open to alternative solutions, then the students develop confidence in themselves as problem solvers. Thus, problem solving both requires self-confidence and develops self-confidence. As Schoenfeld (1992) reports, students' beliefs and attitudes about learning mathematics affect their understanding. The development of metacognitive skills supports the development of problem-solving skills.

Teachers used authentic assessment and their linked activities so that students could develop a deeper understanding of mathematics. Teachers also wanted students to see the relevance of mathematics, be able to apply mathematics to solve problems in other contexts, and develop the confidence and skills necessary to make use of the mathematics that they learned.

Facing dilemmas

The greatest dilemmas faced by the participants included balancing traditional expectations in the curriculum with authentic assessment activities, matching new assessment techniques with traditional reporting methods, and dealing with feelings of isolation and alienation from colleagues. This particular section deals with these dilemmas. Other issues that arose involve the types of supports that teachers require, such as time to explore, develop, or find appropriate curriculum and assessment resources; administrative support; and sound professional development. These issues will be presented in the subsequent section on 'Supporting the Use of Authentic Assessment.'

Covering the content: Working within a traditional framework

All five teachers were trying to combine the traditional course content and traditional testing with other activities, which were generally problem-based or included self-reflection on the students' own learning and were assessed using authentic assessment strategies. These teachers had to cover prescribed content so that they could ensure that students were well prepared for the common course examination set by the teachers teaching the course. The teachers in the study frequently

questioned the importance of the prescribed content and felt as though there were other, more significant mathematics concepts that could be experienced.

Covering the content is the term that teachers use to describe the pressure that they feel to 'pack in' many distinct (sometimes seemingly unconnected) topics that have been designated as part of the mathematics curriculum. The pressure to cram so many topics into so little time often forces teachers to teach mathematics as a series of memorized algorithms rather than to strive for student understanding of mathematics. The experiences of these participants appeared very similar to the experiences of the participants in a study by Rowley, Brew, and Ryan (1996), which reported that teachers felt pulled in two directions by the need to cover the content while, at the same time, doing activities that they believed would give students a deeper understanding of mathematics, help them make connections to mathematics, and allow them to take responsibility for their own learning. Lampert (2001) suggests that covering the curriculum assumes a linear approach to learning and that curriculum could be re-conceptualized around significant *conceptual fields*. She also suggests that such a re-conceptualized curriculum would prompt the need for authentic types of assessment.

The participants pointed to several ways of dealing with the dilemma of covering the content while also using problem-solving activities. At times, the teacher began the unit with a problem in context so that the students might see the purpose of pursuing a set of skills that would help them determine the solution to the problem. In other cases, the teacher would first teach the content and then use problem-solving activities as a follow-up. Julia mentioned that she saw a dichotomy between learning the rules and then applying them to an activity: 'If I feel that I'm just teaching the unit and the kids are just doing all the rules and I think that's kind of the way the unit is set up. Then I try to take the time to find an activity or something that will enhance that and make them think a little bit more. Because I think it helps them learn. It helps them become better students' (Julia, interview transcript). All noted, however, that mathematics education was in transition from a content-oriented curriculum toward a problems-based curriculum and expressed confidence that, in due time, the curriculum would better support the types of activities they felt were important. In fact, several of the participants felt that they could create such a curriculum, if given the time to create and implement it. Julia expressed her vision of what the curriculum could be:

> I want to start from scratch, sit down with somebody and completely change the way we teach Grade 9. I can picture what I would do. I want to do many more activities, much more discovery, much more group problem solving. I would love to do more projects as they are learning different skills as they work through the project, not so much a topic-by-topic approach. This means revamping the entire way we teach the course. (Julia, interview transcript)

In a focus-group discussion, Miriam confirmed that a new curriculum was needed and suggested that a problem-solving curriculum could lead in many different directions.

The participants felt that one stumbling block to introducing a problems-based curriculum was that the teacher needs to be very confident and knowledgeable about mathematics to resolve student questions and provide suitable prompts to students as they move through investigations and explorations. Luke suggested that teachers would need to be comfortable with a more open-ended approach: 'It means that you need a great knowledge of the course. Even an experienced math teacher, unless they know the course well and can see connections that can be made and can be drawn out would have a hard time. So you need to know the course and you need to know the mathematics' (Luke, focus-group interview). Dave was hopeful that the changes in the mathematics curriculum would help to alleviate the struggle that the participants felt. They viewed themselves in a state of transition. As with several other studies (Borko, 1997; Flexer, 1995; Ryan, 1994; Shepard, 1994) teachers reported making curricular changes such as re-sequencing curriculum, introducing new concepts, and emphasizing process rather than content.

As the teachers considered the pressure they felt to cover the content, the issue of examinations arose. They felt that exams were driving what was being taught and how it was being taught and that perhaps the format or purpose of exams should be reconsidered. Several of the participants felt compelled to cover the content so that their students would be prepared for the final examination. Julia believed that problem-solving and authentic-assessment activities were important but she did not want the time spent on those activities to be time taken away from examination content, since that might disadvantage her students. Gwen suggested that most teachers see the examinations as 'driving the curriculum.' Miriam suggested that this does not necessarily allow for the spontaneity that a problem-solving curriculum entails. This notion is supported by Neill and Medina (1989): 'As teaching becomes "coaching for the test" in too many schools, real learning and real thinking are crowded out. Among the instructional casualties are higher-order thinking skills' (p. 694).

Miriam suggested that a solution might be to have examinations disappear. Dave suggested that the final examination could take a completely different format, such as the in-class examination component, incorporating technology, that was used in his department. Several of the participants offered alternatives to traditional examinations, including performance assessment tasks as summative assessments.

Assessment and instruction are intrinsically linked. The teachers' need to use authentic assessment emerged as their instructional practices moved from a more traditional style to the use of such things as contextual problems, cooperative learning, and an emphasis on communication. In both assessment and instruction, they felt caught in the middle. They felt that they needed to teach a traditional curriculum to prepare students for a traditional examination. However, they also felt compelled to instruct, and thus assess, in a variety of ways.

The problem of isolation

The participants often spoke of feeling as though they were working in isolation, or worse, were seen as the odd person out. These participants saw themselves as doing things differently from their colleagues and they perceived that their colleagues saw them that way as well. The participants' feelings of isolation were very strong. They hesitated to share their ideas because they felt as though they needed to be on the defensive or be prepared for criticism. Julia mentioned that '[t]o a large degree I don't tell people what I'm doing or I'll wait until I've done it and see whether or not I really liked it before I tell them. But if it is something that I think went well and I think is worthwhile then I share it' (Julia, interview transcript). All of the participants expressed similar reservations. These teachers felt like outsiders in their own departments and often received negative feedback when they shared some of their ideas. In a focus-group meeting, Gwen reported that

> I said to one person in my department that I had done a self-evaluation at the end of a unit and they said 'Oh, I used to do that and try to relate it all to the report card but in the end I am going to give them the same check mark anyway so it doesn't really do me any good.' They seemed to miss the point that it was the kid who was going to get something out of the self-evaluation. (Gwen, focus-group interview)

Luke often expressed his frustration at feeling different from the rest of his department at the secondary school level. Although Luke reported that he had more time at the elementary level to try innovative ideas, he also reported that he still felt isolated. Other teachers were not attempting to implement and assess the curriculum in the same way that he did.

Even though these teachers felt isolated, they still continued to try new things in the classroom. They believed in what they were doing and they saw students developing an understanding of mathematics. They saw these experiences as part of their professionalism and often wondered or became frustrated that other teachers did not see it this way. The question arose, 'Why are the other colleagues so suspicious of these ideas?' Dave suggested that '[e]ven the young teachers have old

thoughts' (interview transcript). Some suggested that these forms of assessment were difficult for many teachers because they might not feel comfortable enough with the mathematics to venture into open-ended problem solving: 'They are math teachers but they are not [math teachers], because they don't have a strong math background. I don't think that they have experienced math that way themselves and it is a pretty huge task' (Luke, interview transcript).

However, when the teachers shared their ideas with others in their department, they occasionally shifted other teachers' views of authentic assessment activities by giving them samples of activities that they had tried themselves. Miriam had an experience of teaching one of her colleagues a different way of teaching integers to Grade 9 students, using bingo chips:

> I know I had a teacher last year and I showed him how to teach integers using bingo chips and this guy finally tried it because I said that I am going to put a modelling question on integers using bingo chips on the exam so you will need to do it with his students. Well, there was a lot of grumbling and commotion and he tried it and then noticed that the kids were flying through the questions. He was sold on the idea. He fought for years and then tried it and was so excited and loved it. (Miriam, focus-group interview)

Luke suggested that teachers need to share ideas in order to develop new strategies. Yet, Luke also warned about being sensitive to other colleagues and not forcing these approaches as the 'right way' to teach. The participants felt that what they were doing had value; yet, they did not feel that they were 'authorities' who could prove that this was the best way to teach mathematics.

One problem with isolation is that it can lead to a lack of consistency in assessment among instructors. The reality of some teachers' incorporating new teaching and assessment strategies while others are not creates issues of incongruity, incoherence, and questionable accountability. Several of the participants recognized that there was a wide gap between colleagues about issues of assessment, and this concerned them. As supported by several studies (Morony & Olssen, 1994; Rowley, Leder, & Brew, 1994; Rowley et al., 1996) teachers need to be supported and provided with informal opportunities to discuss and debate issues. If teachers are going to increase their expertise with authentic assessment then teachers need to talk about their experiences. In fact, Miriam suggested that our first focus-group interview energized her. She believed that the discussion was very stimulating and commented that '[t]eachers just don't have enough time to talk to one another'(informal interview). Others confirmed this. Gwen and Julia often worked together in their department and developed and shared activities. They reported that this sharing helped to alleviate the feeling of isolation and helped them to develop and affirm new ideas through discussion. Collaborative work among teachers allows for the sharing of expertise in areas of assessment, and, as supported by several studies (Clarke, 1996; Morgan & Watson, 2002), greater consistency in assessment can be developed through discussion of assessment criteria and student work.

Authentic assessment and reporting

Several of the teachers discussed the difficulty of matching authentic assessment techniques with a more traditional method of reporting using percentage marks. The data gathered through authentic assessment frequently consists of levels on a rating scale or rubric or is anecdotal. This type of information is unsuited to being directly translated into a percentage mark. Wiggins (1994) confirms that translating rich assessment data into a mark or grade for a report card is a dilemma: 'Why, then, do we arbitrarily average grades and scores in school—where the dimensions of performance are even more complex and diverse—to arrive at a single grade per subject? Problem solving is not research, is not writing, is not discussing, is not accuracy, is not thoroughness, and is not mastery of the facts' (p. 35). The participants' experiences confirm this, as all of the participants found it difficult to convert authentic assessment to a mark at levels other than Grade 9. Gwen mentioned, 'I think the hardest thing right now is, except at the Grade 9 level, trying to relate

authentic assessment to a mark. In the other levels, that's where I find I'm having a little bit of dif-ficulty' (interview transcript). Julia also had difficulty using authentic assessment with her more senior grades, whereas, for Grade 9, she could report levels of student achievement. Julia used authentic assessment in her Grade 12 class and then converted that assessment data into a percent-age mark. Using reporting methods that relate to levels definitely makes it easier to adapt authentic assessment to the evaluation of students. Luke used levels of achievement with his Grade 8 class, and Gwen and Julia reported achievement with check marks on a rating scale for their Grade 9 classes. These three participants believed that it was easier to link assessment and the reporting of progress when the emphasis was on levels of achievement rather than strictly on a percentage grade.

Gwen believed that students and parents received more information from a report card that dis-cusses levels of achievement on several different outcomes rather than from an overall percentage mark. She was a firm advocate of this method of reporting and believed that parents and students benefited. Julia also believed that her school's Grade 9 report card was useful to students: 'I think just in terms of feedback to students, I think it's really helpful rather than just giving them a mark. I think it is good to continue to mark things in this way. Maybe I should be doing that more with my Grade 12 class. Maybe I should give them more anecdotal information about where their strengths are and where their weaknesses are' (interview transcript). Julia further remarked that the set-up of the Grade 9 report card actually encouraged her to use other forms of assessment rather than paper-and-pencil tests.

Supporting the use of authentic assessment

Several points arose from this study about enhancing the quality of authentic assessment prac-tices, including the role a partnership between students and teachers plays in their being more aware of authentic assessment strategies, the importance of providing teacher resources about assessment and providing effective teacher development in assessment, and the value of adminis-trative support.

Partnerships

Increasing colleagues', students', parents', and administrators' understanding of new assess-ment methods is essential to supporting teachers' use of authentic assessment practices. The partic-ipants considered collaboration with colleagues an important aspect in developing expertise and increasing consistency in assessment. It was also important to increase students' and parents' awareness of authentic assessment and to share with them the purpose of new instructional and assessment strategies. Lester and Kroll (1990) suggest that assessment methods communicate to students, parents, and administrators what is considered important. The participants explained that students became more comfortable with authentic assessment as their familiarity increased over time.

> Once you sort of go over it with them, later, then you can say this is sort of what I was looking for. Then they get better. They say 'Oh, that's what you mean, that's what you wanted.' … That is sort of what happens when students get used to us giving them the right answer … I mean I think it's not so much the students who need to change but it's the teachers too. (Miriam, focus-group interview)

Luke recognized that the students actually felt more relaxed with an authentic assessment activity because it alleviated the stress of a paper-and-pencil test, where resources or communica-tion are prohibited. Several participants used exemplars (or samples of student work) that showed students the type of criteria that were used to reflect a particular level of achievement. Most of the